OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **FOREST LAKE**, **WHITEFIELD/DALTON**, the program coordinators have made the following observations and recommendations:

We would like to thank your group for sampling your lake **once** this summer. However, we encourage your monitoring group to sample **additional** times each summer. Typically we recommend that monitoring groups sample **three times** per summer (once in **June**, **July**, and **August**). We understand that the number of sampling events you decide to conduct per summer will depend upon volunteer availability, and your monitoring group's water monitoring goals and funding availability. However, with a limited amount of data it is difficult to determine accurate and representative water quality trends. Since weather patterns and activity in the watershed can change throughout the summer, from year to year, and even from hour to hour during a rain event, it is a good idea to sample the lake at least once per month over the course of the season.

If you are having difficulty finding volunteers to help sample, or to pickup or drop-off equipment at one of the laboratories, please give the VLAP Coordinator a call and we will try to help you work out an arrangement.

As part of the state's lake survey program, DES biologists performed a comprehensive lake survey on **FOREST LAKE** in **September** this summer. Publicly-owned recreational lakes in the state are surveyed approximately every ten to fifteen years. In addition to the tests normally carried out by VLAP, biologists tested for certain indicator metals and nitrogen, created a map of the lake bottom contours (referred to as a bathymetric map), and mapped the abundance and distribution of the aquatic plants along the shoreline. DES biologists will also sample the lake once during the Winter of 2005-2006. Some data from this lake survey have been included in this report and has been added to the historical database for your lake. If you would like a complete copy of the raw data from the lake survey, please contact the DES Limnology Center at (603) 271-3414 or (603) 271- 2658. A final report should be available in 2007 and a copy will be available at any state library.

We would like to encourage your monitoring group to formally participate in the DES Weed Watchers program, a volunteer program dedicated to monitoring lakes and ponds for the presence of exotic aquatic plants. This program only involves a small amount of time during the summer months. Volunteers survey their waterbody once a month from June through September. To survey, volunteers slowly boat, or even snorkel, around the perimeter of the waterbody and any islands it may contain. Using the materials provided in the Weed Watchers Kit, volunteers look for any species that are of suspicion. After a trip or two around the waterbody, volunteers will have a good knowledge of its plant community and will immediately notice even the most subtle changes. If a suspicious plant is found, the volunteers will send a specimen to DES for identification. If the plant specimen is an exotic, a biologist will visit the site to determine the extent of the problem and to formulate a plan of action to control the nuisance infestation. Remember that early detection is the key to controlling the spread of exotic plants.

If you would like to help protect your lake or pond from exotic plants, contact Amy Smagula, Exotic Species Program Coordinator, at 271-2248 or visit the Weed Watchers web page at www.des.state.nh.us/wmb/exoticspecies/survey.htm.

FIGURE INTERPRETATION

Figure 1 and Table 1: The graphs in Figure 1 (Appendix A) show the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the lake has been monitored through the program.

Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m³.

The current year data (the top graph) show that the chlorophyll-a concentration *increased* from the **July** to **September** sampling event. The chlorophyll-a concentration on the **July** sampling event was *less than* the state median and similar lake median (refer to Appendix F for more information about the similar lake median).

The historical data (the bottom graph) show that the 2005 chlorophyll-a mean is **slightly greater than** the state median and is **slightly less than** the similar lake median.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **variable** in-lake chlorophyll-a trend since monitoring began. Specifically, the concentration has **fluctuated between** approximately 3.2 and 7.9 mg/m³ since 1989.

Please keep in mind that this trend is based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

In the 2006 annual report, since your group will have sampled the chlorophyll-a concentration at the deep spot for at least 10 consecutive years, we will conduct a statistical analysis of the historic data to determine if there has been a significant change in the annual mean since monitoring began.

While algae are naturally present in all lakes, an excessive or increasing amount of any type is not welcomed. In freshwater lakes, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase with an increase in nonpoint sources of phosphorus loading from the watershed, or in-lake sources of phosphorus loading (such as phosphorus releases from the sediments). Therefore, it is extremely important for volunteer monitors to continually educate residents about how activities within the watershed can affect phosphorus loading and lake quality.

Figure 2 and Table 3: The graphs in Figure 2 (Appendix A) show historical and current year data for lake transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the lake has been monitored through the program.

Volunteer monitors use the Secchi-disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.

The current year data (the top graph) show that the in-lake transparency *decreased* from the **July** to **September** sampling event. The transparency on the **July** sampling event was *slightly greater*

than the state median and similar lake median (refer to Appendix F for more information about the similar lake median). The transparency on the **September** sampling event was **slightly less than** the state median and **slightly greater than** the similar lake median

It is important to note that as the chlorophyll concentration *increased* from the **July** to **September** sampling event at the deep spot this season, the transparency **decreased**. We typically expect this *inverse* relationship in lakes. As the amount of algal cells in the water *increases* the depth to which one can see into the water column typically **decreases**.

The historical data (the bottom graph) show that the 2005 mean transparency is **approximately equal to** the state median and is **slightly greater than** the similar lake median.

Overall, visual inspection of the historical data trend line (the bottom graph) shows a **decreasing** (**meaning** worsening) transparency trend since monitoring began in 1989.

Again, please keep in mind that this trend is based on limited data. As your group expands its sampling program to include additional events each year, we will be able to determine trends with more accuracy and confidence.

As previously discussed, since your group will have sampled the transparency at the deep spot for at least 10 consecutive years, the 2006 annual report will include a statistical analysis of the historic data to determine if there has been a significant change in the annual mean since monitoring began.

Typically, high intensity rainfall causes erosion of sediments into lakes and streams, thus decreasing clarity. Efforts should continually be made to stabilize stream banks, lake shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the lake. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

Figure 3 and Table 8: The graphs in Figure 3 (Appendix A) show the amount of phosphorus in the epilimnion (the upper layer) and the hypolimnion (the lower layer); the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the lake has joined the program.

Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Too much phosphorus in a lake can lead to increases in plant and algal growth over time. The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.

The current year data for the epilimnion show that the phosphorus concentration **decreased slightly** from the **July** to **September** sampling event. The phosphorus concentration on **each sampling event** was **less than** the state median and similar lake median.

The current year data for the hypolimnion show that the phosphorus concentration on the **July** sampling event was **less than** the state median and similar lake median. The hypolimnion was not sampled on the **September** sampling event.

Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a *variable* phosphorus trend since monitoring began in **1989**.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and value of lakes and ponds. Phosphorus sources within a lake or pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

> Table 2: Phytoplankton

Table 2 (Appendix B) lists the current and historical phytoplankton species observed in the lake. Specifically, this table lists the three most dominant phytoplankton species observed in the sample and their relative abundance in the sample.

The dominant phytoplankton species observed in the **July** sample were **Chrysosphaerella** (golden-brown), **Asterionella** (diatom), and **Dinobryon** (golden-brown).

Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

> Table 2: Cyanobacteria

A small amount of the cyanobacteria Anabaena and Microcystis were observed in the July plankton sample. This species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans. (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased (this is often caused by rain events) and favorable environmental conditions occur (such as a period of sunny, warm weather).

The presence of cyanobacteria serves as a reminder of the lake's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the lake by eliminating fertilizer use on lawns, keeping the lake shoreline natural, revegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

In addition, residents should also observe the lake in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the lake. If a fall bloom occurs, please collect a

sample (any clean jar or bottle will be suitable) and contact the VLAP Coordinator.

> Table 4: pH

Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the surface waters in the state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The pH at the deep spot this season ranged from **6.76** in the hypolimnion to **7.00** in the epilimnion, which means that the water is **slightly acidic near** the lake bottom and **approximately neutral** near the lake surface.

It is important to point out that the pH in the hypolimnion (lower layer) was *lower (more acidic)* than in the epilimnion (upper layer). This increase in acidity near the lake bottom is likely due the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the presence of granite bedrock in the state and acid deposition (from snowmelt, rainfall, and atmospheric particulates) in New Hampshire, there is not much that can be done to effectively increase lake pH.

> Table 5: Acid Neutralizing Capacity

Table 5 (Appendix B) presents the current year and historical epilimnetic ANC for each year the lake has been monitored through VLAP.

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **8.0 mg/L** this season, which is **greater than** the state median. In addition, this indicates that the lake is **moderately vulnerable** to acidic inputs (such as acid precipitation).

> Table 6: Conductivity

Table 6 (Appendix B) presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current (which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column). The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual conductivity in the epilimnion at the deep spot this season was **51.59 uMhos/cm**, which is **greater than** the state median.

The conductivity has gradually increased in the lake since monitoring began. In addition, the conductivity has been elevated and has fluctuated greatly in the North Inlet and State Beach Brook since monitoring began. Typically, increasing/elevated conductivity are due to human activity. These activities include septic systems, agricultural runoff, and road runoff (which contains road salt during the spring snow melt). development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We recommend that your monitoring group conduct a stream survey and storm event sampling along the **North Inlet** and **State Beach Brook** so that we can determine potential sources of conductivity to the lake.

For a detailed explanation on how to conduct rain event sampling and stream surveys, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

Table 8: Total Phosphorus

Table 8 (Appendix B) presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was **elevated** (23 ug/L) in the State Beach Brook inlet on the July sampling event. This station has had a history of **elevated** and **fluctuating** total phosphorus concentrations. We recommend that your monitoring group conduct a stream survey and storm event sampling along this inlet so that we can determine what may be causing the elevated phosphorus.

For a detailed explanation on how to conduct rain event sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

> Table 9 and Table 10: Dissolved Oxygen and Temperature Data

Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2005 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The dissolved oxygen concentration was lower in the hypolimnion (lower layer) than in the epilimnion (upper layer) at the deep spot of the lake/pond on the **Month** sampling event. As stratified lakes/ponds age, and as the summer progresses, oxygen typically **depleted** in the hypolimnion by the process becomes decomposition. Specifically, the loss of oxygen in the hypolimnion results primarily from the process of biological breakdown of organic matter (i.e.; biological organisms use oxygen to break down organic matter), both in the water column and particularly at the bottom of the lake/pond where the water meets the sediment. When oxygen levels are depleted to less than 1 mg/L in the hypolimnion, the phosphorus that is normally bound up in the sediment may be rereleased into the water column (a process referred to as internal phosphorus loading).

> Table 11: Turbidity

Table 11 (Appendix B) lists the current year and historical data for inlake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

The tributary and deep spot turbidity was **relatively low** this season which suggests that erosion may not be a major contributor of sediment and nutrient loading to the lake. This is good news and we hope to see this trend continue.

> Table 12: Bacteria (E.coli)

Table 12 lists the current year and historical data for bacteria (E.coli) testing. (Please note that Table 12 now lists the maximum and minimum results for this season and for all past sampling seasons.) E. coli is a normal bacterium found in the large intestine of humans and other warm-blooded animals. E.coli is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage MAY be present. If sewage is present in the water, potentially harmful disease-causing organisms MAY also be present.

The *E. coli* concentration at the **State Beach Brook** was *elevated* on the **July** sampling event. Specifically, the result of **110** counts per 100 mL *was greater than* the state standard of 88 counts per 100 mL for designated public beaches.

We recommend that your group continue *E.coli* sampling at this station next season. If the results continue to be **elevated**, we will recommend that your group conduct a series of tests on a weekend during heavy beach use and also immediately after a rain event. This additional sampling may help us determine the source of the bacteria.

For a detailed explanation on how to conduct rain event sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

> Table 13: Chloride

The chloride ion (Cl-) is found naturally in some surfacewaters and groundwaters and in high concentrations in seawater. Research has shown that *elevated* chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes

is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The **epilimnion** was sampled for chloride during the **September** comprehensive lake survey. The result was **6.0 mg/L** which is **much less than** the state acute and chronic chloride criteria. This indicates that road salt may not be a major contributor of chloride and conductivity to the lake.

> Table 14: Current Year Biological and Chemical Raw Data

This table lists the most current sampling season results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw" (meaning unprocessed) data. The results are sorted by station, depth zone (epilimnion, metalimnion, and hypolimnion) and parameter.

> Table 15: Station Table

As of the Spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past (and are most familiar with), an EMD station name also exists for each VLAP sampling location. For each station sampled at your lake, Table 15 identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your lake, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors fail to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the

volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an **excellent** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

USEFUL RESOURCES

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES Booklet WD-03-42, (603) 271-2975.

Best Management Practices for Well Drilling Operations, NHDES Fact Sheet WD-WSEB-21-4, (603) 271-2975 or www.des.nh.gov/factsheets/ws/ws-21-4.htm.

Biodegradable Soaps and Water Quality, NHDES Fact Sheet BB-54, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-54.htm.

Canada Geese Facts and Management Options, NHDES Fact Sheet BB-53, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-53.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet WMB-10, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, NHDES Fact Sheet WD-SP-1, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-1.htm.

Impacts of Development Upon Stormwater Runoff, NHDES Fact Sheet WD-WQE-7, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-7.htm.

Iron Bacteria in Surface Water, NHDES Fact Sheet WD-BB-18, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-18.htm.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, NHDES Fact Sheet WD-BB-9, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Watershed Districts and Ordinances, NHDES Fact Sheet WD-WMB-16, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-16.htm.